coupling the chuck to the pedestal;

coupling the wafer to the coupled chuck;

B3 end

rotating the pedestal so as to rotate the coupled chuck and the coupled wafer; and

plasma etching the rotating wafer.

REMARKS

Reconsideration and allowance of this application, as amended, are respectfully requested. The written description and claims 10, 11, and 15 have been amended, and new claim 26 has been added. Claims 10-16 and 26 are now pending in the application. The objection and the rejection are respectfully submitted to be obviated in view of the amendments and remarks presented herein.

In the present Amendment, the written description has been amended to correct the section heading at page 6, and claim 15 has been amended to correct the inadvertent misspelling of "wafer." Claims 10, 11, and 15 have been amended for improved readability.

New claim 26 has been added to augment the scope of protection to be accorded the invention. Support for the recitation of the apparatus feature of the method defined in claim 26 is found at specification page 6, line 2, through page 11, line 15, and in the depiction of the invention in Figures 1-3.

Entry of each of the above amendments is respectfully requested.

35 U.S.C. § 103(a) – Saeki in view of Nakayama

Turning to the Office Action, claims 10-16 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. Patent No. 5,460,684 to Saeki et al. (hereinafter "Saeki") in view of U.S. Patent No. 4,902,531 to Nakayama et al. ("Nakayama").

The Office Action acknowledges that "Claim 10 differs from Saeki et al. by specifying that the pedestal is rotating during plasma etching of the wafer," and relies upon Nakayama for the disclosure of "a vacuum processing method and apparatus wherein a susceptor, which supports a substrate to be processed and is fixed to a rotating shaft, is contained within a vacuum chamber." The Office Action asserts that "Nakayama et al.'s susceptor reads on applicant's pedestal," and concludes that "a person having ordinary skill in the art at the time of the claimed invention would have found it obvious to modify Saeki et al. by using a rotating susceptor, as disclosed by Nakayama et al., because it would have been anticipated to produce an expected result."

With regard to claim 15, the Office Action asserts that "a person having ordinary skill in the art at the time of the claimed invention would have found it obvious to control the process parameters, as listed in claim 15, because control of each process parameter would be inherent in plasma etching methods and apparatuses and their combination would have been anticipated to produce an expected result."

The rejection of claims 10-16 under § 103(a) as being unpatentable over Saeki in view of Nakayama is respectfully traversed. The combined disclosures would not have rendered obvious the embodiments of the method defined by any of claims 10-16.

The claimed invention would not have been obvious because there is no suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to combine reference teachings.

Saeki is directed to a plasma etching apparatus. Nakayama is directed to "a method of and an apparatus for processing substrates in [a] vacuum chamber, *such as chemical vapour deposition* (CVD)" (column 1, lines 7-9)(emphasis added). Thus, while Saeki is directed to the removal of material (as is Applicants' claimed method), Nakayama is directed to the deposition of material.

Saeki's apparatus for removing material is not rotatable. Nakayama's method of adding material employs an apparatus that is rotatable. There is no suggestion in either Saeki or Nakayama, however, to combine reference teachings so as to arrive at Applicants' claimed method of removing material which comprises the steps of "rotating the pedestal; and plasma etching the wafer while the pedestal is rotating."

For example, at column 7, lines 21-24, Nakayama describes the advantage associated with rotating his susceptor: "[o]n the surface of the substrate positioned on the susceptor 11 there can be uniformly *formed* a thin film which includes the components of the reactive gas."

Applicants respectfully submit, however, that the principles associated with forming a film through chemical vapor deposition are complex, and are not necessarily the same as the principles associated with removing material through plasma etching. For example, "[t]he fundamental principles of CVD involve a wide variety of scientific and technical disciplines, including gas-phase reaction chemistry, thermodynamics, kinetics, heat transfer, fluid mechanics, surface reactions, plasma reactions, film growth phenomena, and reactor engineering." Wolf, S. "Chemical Vapor Deposition of Amorphous and Polycrystalline Thin Films," *Silicon Processing for the VLSI Era*, (Lattice Press, 2000), Vol. 1, Ch. 6, p. 149 (photocopy attached).

Furthermore, certain of the characteristics of the resultant deposited film are different from the characteristics that one would consider in removing material through plasma etching. For example, the required characteristics of a deposited film include film uniformity, but *also* include "b) high purity and density; c) controlled composition and stoichiometry; d) high degree of structural perfection; e) good electrical properties; f) excellent adhesion; g) good step coverage; and h) low defect density." Wolf, p. 149.

Thus, plasma etching is different from chemical vapor deposition, and at specification page 3, lines 1-7, Applicants disclose a particular problem associated with conventional methods of plasma etching:

> In [a] conventional pattern plasma etched apparatus, the chuck is stationary to allow for cooling. Non-uniform etching occurs, however, due to chamber design or process parameters resulting in undesirable film thickness deviations. These

> deviations in film thickness can be localized or spread across the entire film surface.

Then, at specification page 3, lines 9-19, Applicants describe their claimed invention as the solution to the aforementioned problem:

> The present invention overcomes these shortcomings by providing an internally cooled rotatable chuck for use in a semiconductor wafer plasma etching apparatus. By rotating the chuck and the wafer in an etching chamber, the effect of the inherent lack or excess of ions due to chamber design or process parameters can be minimized. The lack or excess of ions creating the etch can be spread across the entire wafer surface assuring all locations see the same etch parameters. Accordingly, a more efficient process with better film uniformity will be realized.

Applicants respectfully submit that the assertion in the Office Action that it would have been "obvious to modify Saeki et al. by using a rotating susceptor, as disclosed by Nakayama et al., *because it would have been anticipated to produce an expected result*" (emphasis added), is insufficient to establish a *prima facie* case of obviousness. First, the Office Action fails to either describe or even suggest *what* that "expected result" would be.

Secondly, in view of both the above-described complex nature of chemical vapor deposition, and Applicants' description of the film uniformity problem associated with plasma etching, it is simply impossible to conclude from the combined teaching of Saeki and Nakayama, as the Office Action does, that any particular "expected result" would occur, let alone Applicants' "better film uniformity."

It is respectfully submitted, therefore, that there is neither a suggestion nor a motivation in the asserted combination to derive the embodiment of the invention defined by Applicants' independent claim 10. Thus, the asserted combination would not have rendered obvious the method defined by Applicants' claim 10.

Rejected dependent claims 11-16 are allowable along with claim 10, and on their own merits. For example, regardless of the assertion in the Office Action that "a person having ordinary skill in the art . . . would have found it obvious to control the process parameters" defined in claim 15, there is, for all of the reasons outlined above, no suggestion in either Saeki or Nakayama to combine reference teachings so as to arrive at the method of "plasma etching the wafer while the pedestal is rotating" as defined in Applicants' independent claim 10. Addition of the step of initializing process parameters as defined by claim 15 simply contributes even further to the unobviousness of the claimed invention.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 10-16 under § 103(a) are respectfully requested.

The canceled and/or amended claims have been canceled and/or amended solely for the purpose of furthering the prosecution of the present application. Applicants reserve the right to claim the subject matter of the canceled claims, the claims pending prior to this Amendment, and/or the subject matter of other claims embodied in this

application, or any continuation, division, CPA, RCE, subsequent reissue, reexamination or other application. Any amendments made to the application are not made for the purpose of distinguishing the claims over prior art except as specifically discussed in the Remarks section of this paper. Applicants may file a continuing application with claims that do not contain the limitations discussed in this paper, and Applicants expressly reserve the right to do so.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

By____________________

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<u>Version with markings to show changes made</u>

<u>In the Written Description</u>:

Page 6, line 1 (the section heading), delete "DRAWING" and insert --INVENTION--.

<u>In the Claims</u>:

Please amend the claims as follows:

10. (Amended) A method for plasma etching <u>a</u> wafer comprising the steps of:

coupling a chuck to a pedestal;

coupling the wafer to the chuck;

rotating the pedestal; and

plasma etching the wafer while the pedestal is rotating.

11. (Amended) The method of claim 10 further comprising the [steps] <u>step</u> of internally cooling the chuck.

15. (Amended) The method of claim 10 further comprising the [steps] <u>step</u> of initializing process parameters, the process parameters [including] <u>comprising</u> gas flow, process chamber pressure, [water] <u>wafer</u> temperature, and pedestal rotation speed.

Chapter 6

CHEMICAL VAPOR DEPOSITION of AMORPHOUS and POLYCRYSTALLINE THIN FILMS

Chemical vapor deposition (CVD) is defined as the formation of a solid film on a substrate by the reaction of vapor-phase chemicals (reactants) that contain the required constituents. The reactant gases are introduced into a reaction chamber and are decomposed and/or reacted at a heated surface to form the thin film. Note that in CVD the reactant gases do not react with (and therefore do not consume) any substrate surface material. A wide variety of thin films utilized in ULSI fabrication are formed by CVD.[1,2] The deposition of amorphous and polycrystalline thin films by CVD is the subject of this chapter. The growth of single-crystal silicon films by CVD epitaxial techniques is described in Chap. 7.

The fundamental principles of CVD involve a wide variety of scientific and technical disciplines, including gas-phase reaction chemistry, thermodynamics, kinetics, heat transfer, fluid mechanics, surface reactions, plasma reactions, film growth phenomena, and reactor engineering. Obviously these interdisciplinary principles can only be covered very briefly here. Interested readers should consult references for more information on these topics.[3,4]

In this chapter, the mechanisms and a model for thin film growth in CVD are discussed first. Next, the deposition technology and equipment used to prepare such films by CVD are covered. Finally, we consider the properties and deposition conditions of some of the most widely used films deposited by CVD (including polycrystalline silicon, silicon dioxide, silicon nitride, tungsten, aluminum, tungsten silicide, and titanium nitride). Also note that the measurement of many of the properties of CVD films is virtually identical to the measurement of the same properties in other thin films. Thus, only the measurement of those properties that are unique to the specific thin films under discussion will be mentioned here. Readers should consult the index for information on various generic thin film measurement methods.

As discussed in Chap. 4, thin films are used in a host of different applications in ULSI fabrication, and can be prepared using a variety of techniques. Regardless of the method by which they are formed, however, the process must be economical, and the resultant films must exhibit the following characteristics: a) good thickness uniformity; b) high purity and density; c) controlled composition and stoichiometry; d) high degree of structural perfection; e) good electrical properties; f) excellent adhesion; g) good step coverage; and h) low defect density.

Specific deposition methods have been developed to fabricate such thin films, based on the required capabilities for satisfying these demanding criteria. CVD processes are often selected over competing deposition techniques because they offer the following advantages: a) high purity deposits can be achieved; b) a great variety of chemical compositions can be deposited; c) some films cannot be deposited with adequate film properties by any other method; and d) good economy and process control are possible for many CVD deposited films.